MANAGEMENT OF RODENT POPULATIONS AT AIRPORTS

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Abstract: Birds pose serious hazards at U.S. airports because of the potential for collisions with aircraft. Raptors, in particular, are hazardous to aircraft safety due to their size, hunting behavior, and hovering/soaring habits. Reduction of rodent populations at an airport may decrease raptor populations in the area and therefore, reduce the risk that raptors pose to aircraft. Rodent populations can be reduced by population management (i.e., use of rodenticides) or by habitat management (i.e., vegetation management, barriers, and land uses) that reduces the area's carrying capacity for rodents. We discuss potential approaches to reduce rodent populations at airports within the context of an integrated pest management strategy.

Key words: airport, habitat management, IPM, *Microtus*, rodent, rodenticide, vole, wildlife damage, zinc phosphide

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INTRODUCTION

Worldwide, rodents have been, and continue to be, the major vertebrate pest group. Much effort has been, and continues to be, expended to reduce their numbers and damage (Witmer et al. 1995). Rodents are implicated in many types of damage, including crop and tree damage, structural property and cable damage, disease transmission, and significant predation on native species of animals and plants on islands to which rodents have been accidentally introduced (Witmer et al. 1998). Numerous books have appeared in the last decade from all continents or regions of the world, addressing rodent damage and its management (e.g., Corrigan 2001, Singleton et al. 1999).

At the same time, rodents have many important ecological roles and most species are not major pests. Some of the roles include soil mixing and aeration, seed and spore dispersal, influences on plant species composition and abundance, and a prey base for many predatory vertebrates.

Airports often provide good year-round habitat for rodent populations. Rodents at airports can cause damage directly by gnawing and burrowing activities. Larger rodents (e.g., beaver, porcupine, woodchucks) can pose a direct collision hazard to aircraft moving on the ground. It should be noted, however, that larger mammals such as deer and coyotes are considered a much more serious direct strike hazard than are rodents or other mammals (e.g., Dolbeer et al. 2000). Perhaps the most serious hazard posed by a sizeable rodent population at airports, however, is the indirect hazard of attracting foraging raptors with an associated raptor-aircraft strike hazard (e.g., Barras and Seamans 2002). Raptors pose one of the most hazardous groups of birds at the airport setting (Cleary et al. 2002). Unfortunately, many of our activities at airports result in good habitat for rodents (e.g., allowing tall grass in an effort to reduce loafing habitat for flocking birds) or reduced predation of rodents (e.g., perch removal, bird hazing, carnivore-proof perimeter fencing, and raptor and carnivore capture and relocation; see discussion by Barras and Seamans [2002]).

In this paper, we provide background information on the biology and ecology of rodents and the habitats available to rodents at airports. We also discuss human activities and land uses at or near airports that can benefit or adversely affect rodents and, hence, influence the potential for raptor-aircraft collisions. The recommendations are not meant to contravene, in any way, the existing authorities, rules, and regulations of federal, state, and local governmental agencies regarding wildlife, land management activities, and airport management.

The Nature Of Rodents

Over a third of all mammalian species in the world are rodents. They occur on most, if not all, continents. Species have adapted to all life-styles: terrestrial, aquatic, arboreal, and fossorial. Most rodent species are small, secretive, nocturnal, adaptable, and have keen senses of touch, taste, and smell. For most species, the incisors grow throughout the animal=s life, requiring them to be constantly gnawing to keep the incisors at an appropriate length and position. Rodents are known for their high reproductive potential; however, there is much variability among species as to the age at first reproduction, size of litters, and the number of litters per year. Under favorable conditions, populations of some species such as the microtines (e.g., voles) can irrupt, going from less than 100 per ha to several thousand per ha in the period of a few months (e.g., O'Brien 1994). As part of this life strategy, individuals of most rodent species have short life-spans and the annual mortality rates in a population may be as high as 70%. Although rodents are good dispersers, unless conditions are very favorable, mortality rates during dispersal are quite high.

There are many interesting dynamics to various rodent populations that should be understood to better facilitate their management and to reduce damage. The population goes through an annual cycle that may include high and low densities, active and inactive periods, reproductive and non-reproductive periods, and dispersal periods. To avoid inclement periods, some species exhibit a winter dormancy (hibernation), and some species have a summer dormancy (estivation) during hot, dry periods. Some species exhibit multi-year cycles; for example, the microtines often reach population peaks (irruptions) every 3-5 years. Raptors may be attracted to areas such as airports during the "highs" of these population cycles (Baker and Brooks 1981). Even when vole populations "crash", those that survive in grassy "refugia" are able to quickly reproduce and re-invade formerly occupied areas (e.g., Edge et al. 1995, Wolff et al. 1997).

Clearly, it is important to know which rodent species occur at the airport and to have a good understanding of their biology, population dynamics, and ecology along with their relationships to damage, land uses, and human activities.

Monitoring Rodent Populations

It is important to monitor rodent populations at airports. Monitoring allows you to identify the problem species and to conduct pro-active actions, not just retro-active actions. Several to numerous rodent species may occur in any given area, but in many situations only one (or a few) species is causing damage or a problem situation (e.g., high numbers of foraging raptors). Knowing what species are present allows the development of control strategies which account for nontarget species and minimize nontarget losses. Monitoring rodent populations is also very important because densities can fluctuate dramatically within a year and between years. Monitoring also provides additional information on the rodent population: do they breed throughout the year, how rapid is reinvasion, and how far and quickly are animals dispersing.

Obtaining accurate estimates of population density is difficult and costly, in terms of labor, time, and resource requirements. Often, an index that efficiently tracks the population is adequate. A wide array of methods exist for monitoring rodent populations, including trap grids or transects, plot occupancy, open and closed hole indices for burrowing species, bait station or chew card activity and food removal, and runway or burrow opening counts (Engeman and Witmer 2000, Witmer and VerCauteren 2001).

Airport personnel or a contractor should develop and implement a rodent monitoring protocol. This may require some trials with trap placement and potential, palatable baits. Once an effective protocol is developed, it should be implemented in certain areas both inside and outside the perimeter fence. Care must be taken to insure that traps, wire flags, and other materials used in the field for rodent management do not contribute to foreign object damage.

Developing An Integrated Pest Management Strategy

While vertebrate Integrated Pest Management (IPM) has not been as fully explored and implemented as has IPM for invertebrate, weed, and plant disease pests, there has been considerable progress in recent decades. Rodenticide application, causing rapid and large-scale population reduction, continues to be an important tool in rodent damage management. These reductions, however, are short-term and there is a growing concern with the environmental hazards and safety issues associated with rodenticide use. Great strides have been made to better understand the nature of rodent populations, why damage occurs, how damage can be predicted and reduced by non-lethal approaches (physical, chemical, behavioral, and cultural), and how to apply ecologically-based rodent management strategies (e.g., Singleton et al. 1999). The general equipment, methods, and strategies used to manage rodents, including rodenticides, have been presented in detail by Buckle and Smith (1994) and Hygnstrom et al. (1994). Many new approaches (use of disease agents and fertility control) have proven ineffective or ill-conceived for vertebrates in the preliminary testing phases.

Rodent population control requires a careful consideration of 1) the biology and population dynamics of the rodent species, 2) the ecology of the species within its physical and biotic environment, and 3) an understanding of the relationships of the species to human activities. It is only when we have an adequate background in those three areas that we can develop an effective IPM strategy for rodent population and damage management that involves rodent population management, habitat management, and people management (Table 1). Although we seek a relatively easy and long-term solution to the problem, these often do not exist. Therefore, continual, diligent efforts using multiple methods are required. Once an IPM strategy is applied, it is important to monitor the results and to adjust activities as necessary (i.e., incorporate a feedback loop and practice adaptive management).

Table 1. Potential approaches to the management of lower populations of rodents at airports.

Habitat Management	Population Management
Sanitation (food and debris removal)	Trapping
	Rodenticide use
Remove wetlands, riparian habitats, standing water	Enhance natural predation (counter-productive; attracts predators)
Manage substrates, soil Compaction	Fertility control (future?)
Plant monoculture of endophytic grasses or unpalatable plants	Introduce rodent disease or parasite (future?)
Manage vegetation height and amount with mowing, herbicides, burning, or plowing; remove plant residues	
Use artificial turf or other surface cover which prevents burrowing (not practical?)	
Establish rodent-proof barriers (at the perimeter fence), extending above and below the ground surface (needs testing)	
Use crops (soybeans, corn) or livestock grazing outside perimeter fence that do not support high populations of rodents	
Remove animal travel and dispersal corridors leading into airport property	

Several manuals have been developed for guidance on managing wildlife populations and habitats at airports (e.g., Cleary and Dolbeer 1999, Transport Canada 2002). These manuals stress the need to reduce the attractiveness of airports to wildlife through habitat manipulation.

Habitat Management

All rodents require food, shelter, and water. The shelter provides protection from predators, inclement weather, and a favorable place to bear and rear their young. Although rodents require water, those water requirements vary greatly by species. Because rodent food and cover (i.e., vegetation) can be influenced by human activities, there has been considerable development of strategies to reduce populations and damage by manipulating vegetation (Table 1). We will discuss some of these habitat management approaches, but caution that many of them have not been thoroughly investigated or tested on a large scale (e.g., Barras and Seamans 2002).

Good sanitation should be practiced on all areas of the airport. It is especially true around food processing facilities, dumpsters, and employee outdoor eating areas (Barras and Seamans 2002). Commensal rodents, in particular, are prone to exploit these areas. Debris piles (rocks, metal, boards, branches and plant clippings) should not be created as they provide protective cover that most rodents will utilize as burrows, dens, and nest sites. Additionally, airport personnel should anticipate a potential influx of rodents when major airport construction or demolition occurs.

Wetlands, surface water, and riparian areas all provide very good habitat for rodents and other wildlife because of the close proximity of food, cover, and water (Witmer, unpubl. data). These habitats should be removed, or minimized in area, within the perimeter fence and out to 5,000-10,000 feet of aircraft movement areas (Cleary and Dolbeer 1999).

Vegetation height and plant residues can be managed by a number of physical and chemical means---burning, plowing, herbicide application (e.g., Tracy 1999), and mowing (Cornely et al. 1983, Witmer and VerCauteren 2001). It has been well documented that rodent population densities are generally lower when vegetation height is maintained at 20 cm (8 inches) or less (Allen 1998, Barras et al. 2000, Witmer unpubl. data). Mowing is the most commonly used practice to achieve this goal, but it should be recognized that plant residues (i.e., cuttings or thatch) should not be allowed to build up as these provide good overhead cover as well as insulating nest materials for rodents (e.g., Peles and Barrett 1996). Tall grass may dampen the cycles observed with microtines (Getz and Hoffman 1999), with relatively high numbers being maintained year-round. Tall grass can also allow small, resident populations to build up rapidly (Birney et al. 1976). In some situations, even with mowing, vole populations have quickly increased to pre-mowing levels (Edge et al. 1995). Another consideration is that mowing outside the perimeter may result in an influx of rodents to airport property if better cover exists there.

Grass or vegetation type is also an important consideration. Certain types of grass (bluegrass, creeping fescue) appear to be less supportive of rodents than other types such as tall fescue (Sullivan and Vandenbergh 2000). Some varieties of grass, called endophytic grasses, contain an alkaloid-producing fungus that can improve the hardiness of the grass and reduce herbivory. Some preliminary studies suggest that endophytic grass fields support lower rodent densities (Pelton et al. 1991, Witmer unpubl. data).

Other species of plants may be unpalatable to rodents. Trials are currently underway with a plant called meadowfoam to assess its natural repellency of wildlife (Sharon Gordon, personal communication). With any of these approaches, it would be important to maintain essentially a monoculture of the plant type to prevent the availability of an alternative food source. Grasslands at airports are typically neglected, except for mowing, so extra effort and expense would be required to maintain monocultures. Artificial turf has even been suggested as a way to restrict rodent habitat, but in most situations, the approach may be prohibitively expensive.

Barriers to rodent movement or burrowing should be considered. The ability of rodents to construct and maintain burrow systems could be reduced by heavy compaction of the site's soil where vegetation occurs over it. Alternatively, a substrate (e.g., gravel, very fine sand) less supportive of intact burrows could be used. Another possibility would be a layer of mesh or woven material placed over the surface that would allow grass to grow through, but would not allow rodents to move between the surface and the subsurface. Finally, a barrier (e.g., cement or metal flashing) could be established at the perimeter fence, extending at least 25 cm (10 inches) above and below the soil surface to restrict rodent dispersal on to the airport proper. An alternative to this type of barrier would be a shallow, horizontal trench extending out from the perimeter fence about 5 meters (16.4 feet) filled with gravel or other material that would make above and below ground movement difficult for rodents. Of course, these barriers would only be effective if the existing rodent population within the perimeter could be successfully eliminated, or greatly reduced, by the use of rodenticides within the perimeter fence. Also, tall vegetation or deep snow cover, may allow rodents to gain access over vertical barriers. While repellents may have some potential to exclude voles from areas, more research and field trials are needed before effective, commercial products become available (Witmer et al. 2000).

Land uses outside the perimeter fence should not be supportive of rodent populations, especially if a rodent-proof barrier cannot be established. Of course, any of the above vegetation management approaches could be implemented on lands managed by the airport outside the perimeter fence. Additionally, cereal grains should not be grown as these crops support rodents as well as grain-eating birds (Barras and Seamans 2002). Certain crops, such as soybeans and corn, are much less supportive of rodent populations (Witmer unpubl. data). On the other hand, corn fields may attract other mammals and birds. Also, intensive livestock grazing is less supportive of rodent populations (Moser and Witmer 2000, Witmer unpubl. data). Travel ways or dispersal corridors that could be used by wildlife (tree and shrub cover along streams flowing to or from the airport) should also be eliminated (e.g., Barras and Seamans 2002).

Rodent Population Management

Populations of rodents can be reduced by a variety of means. Although methods such as trapping, burning, flooding, and drives have been---and are still being---used in developing countries, many parts of the world have come to rely on rodenticide baits for rodent control (Singleton et al. 1999, Witmer et al. 1995). Considerable development has gone into making rodenticides effective, efficient, and relatively safe for use in buildings or the environment. The use of rodenticides is closely regulated by federal and/or state and provincial governments. In many cases, they can only be applied by a certified pesticide applicator.

Trapping is not very practical for rodent population management, except with some of the larger rodents such as beaver, woodchucks, and porcupines. Trapping can also be used to help control commensal rodents within buildings. Perhaps the most important use of traps in rodent management, however, is as a tool for monitoring rodent populations as discussed earlier.

Rodenticides, in many situations, are the most practical and effective way to reduce a large, widespread rodent population. There are two general classes of oral rodenticides. Acute rodenticides (including zinc phosphide and strychnine) usually kill with a single feeding. In contrast, chronic or multiple-feeding rodenticides (including warfarin, diphacinone, and chlorophacinone) usually require a period (days) of feeding before killing. The distinction has become somewhat blurred because the anticoagulant group includes first generation (examples given) and second generation (bromadiolone, brodifacoum, difethialone) anticoagulants. Second generation anticoagulants are very toxic and can usually kill within several days of a single feeding. These materials are generally not available for field application. Use patterns generally allow rodents to feed continuously at bait stations or on bait blocks, however, so that second generation materials offer no practical advantage in many situations. An additional group of rodent toxicants includes the fumigants (e.g., gas cartridges, aluminum phosphide, methyl bromide) which are used in building fumigation or in burrow systems that are closed after application.

Broadcast baiting with zinc phosphide (ZP; 2% active ingredient) on oats or wheat has worked well for vole (and other small rodent) control at some airports (e.g., Witmer 1999). The bait should be applied early in the year, during a dry period, and pre-baiting with "clean" oats (or wheat) should be done to get good bait acceptance and to avoid the development of "bait shyness" (whereby rodents don't consume a lethal dose, become sick, and won't touch the bait again). ZP does pose a primary hazard to any animal that consumes it so it should be used carefully. On the other hand, ZP is considered to pose very low secondary hazards (to scavengers or predators) because it disperses quickly as phosphide gas and does not bio-accumulate (Johnson and Fagerstone 1994). Rodents do not become bait shy when anticoagulants (chlorophacinone, diphacinone) are used, but there may be greater secondary hazards because the compounds do bio-accumulate. In some situations, the use of bait stations is required for anticoagulant use. If one rodenticide is not working, it is often recommended that a different one be tried. It is preferable to apply rodenticides during more vulnerable times in the rodent's life cycle---often early or late in the year when succulent vegetation for foraging is less abundant.

Airport personnel or contractors should establish an effective rodenticide program to control rodent populations. An effective program would provide a ready tool for a pro-active response to an irrupting rodent population, as determined by the population monitoring protocol.

Other methods of rodent population reduction are not practical or may be counter-productive in an airport setting (e.g., enhancing natural predation) or are not yet registered for field application (introduction of rodent disease agents or parasites, use of fertility control materials).

CONCLUSIONS

Dealing with rodent problems, especially in complex settings with many constraints such as airports, may be difficult. Multiple approaches are available and possible, however, and should be woven into a rodent IPM strategy (Table 1). In some cases, it will be necessary to experiment with approaches on a small scale to see which will be most effective and practical in a specific setting. In general, vegetation, overall setting, and land uses of the airport and adjacent properties should be managed so as to be less supportive of rodents, hence attracting less activity by raptors. The rodent population should be carefully monitored with a standardized protocol so that direct population control can be quickly implemented, if necessary. Hopefully, research will continue to provide a better understanding of rodent populations and access to new or improved methods of population and damage reduction.

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